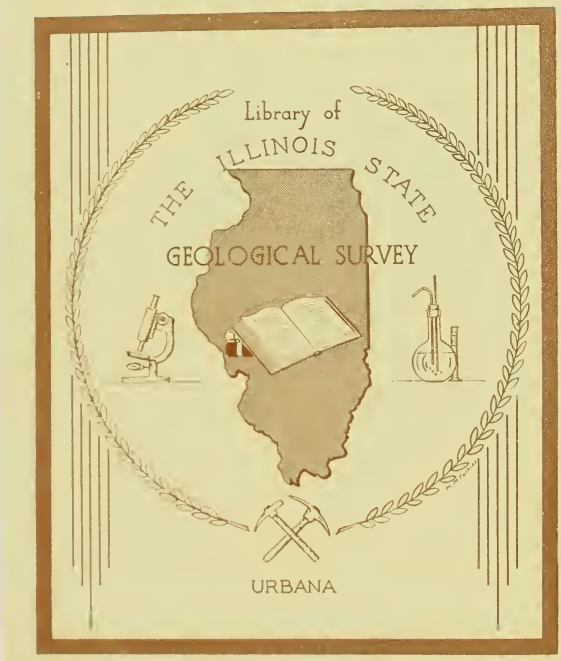
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URANIUM IN ILLINOIS BLACK SHALES

by

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URANIUM IN ILLINOIS BLACK SHALES

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ABSTRACT

One hundred and seventy-five samples of dark gray to black shale were taken from outcrops in 44 Illinois counties. The highest percent equivalent uranium, determined by radiometric assay, of any of the samples was .017. The uranium oxide (U_3O_8) of 15 of the shale samples having the higher percent equivalent uranium ranged between .001 and .014 percent. The uranium oxide averaged .002 percent lower than the percent equivalent uranium for these fifteen samples. Phosphatic nodules and bands found in relatively small quantities in some black shales gave a higher percent equivalent uranium than the shales in which they occur. The maximum uranium oxide content of the phosphatic materials investigated was .075 percent. None of the samples appears to meet the requirement for the minimum grade of ore on which the Atomic Energy Commission has published prices.

Numerous requests have been received by the Illinois State Geological Survey for information regarding the significance of Illinois black shales as possible sources of uranium. This report gives the results of a preliminary investigation to supply such data. It further serves as a basis for judging the importance of the shales in connection with possible future developments in the field of source materials of radioactive substances.

Other members of the Survey staff who have contributed to this report are J. A. Simon and J. E. Lamar. P. E. Potter, H. B. Stonehouse, J. C. Bradbury, and C. W. Spencer aided in the collection of samples.

Geologic Age and Thickness

The black shales of Illinois are principally of Pennsylvanian, Mississippian, and Mississippian-Devonian age. Some Ordovician gray shales were also investigated. The names of the individual units or formations sampled and the identifying numbers are given in table 1.

The Pennsylvanian shales occur most commonly above coal beds. They rarely exceed 10 feet in thickness, are usually less than 5 feet thick, and crop out at many places throughout the State except in the northern fifth, portions of western Illinois, and extreme southern Illinois. One hundred and twenty samples of Pennsylvanian shales were included in this investigation.

Outcrops of shales of the Chester series (Upper Mississippian) occur in extreme southern and southwestern Illinois. Most of these shales are dark gray

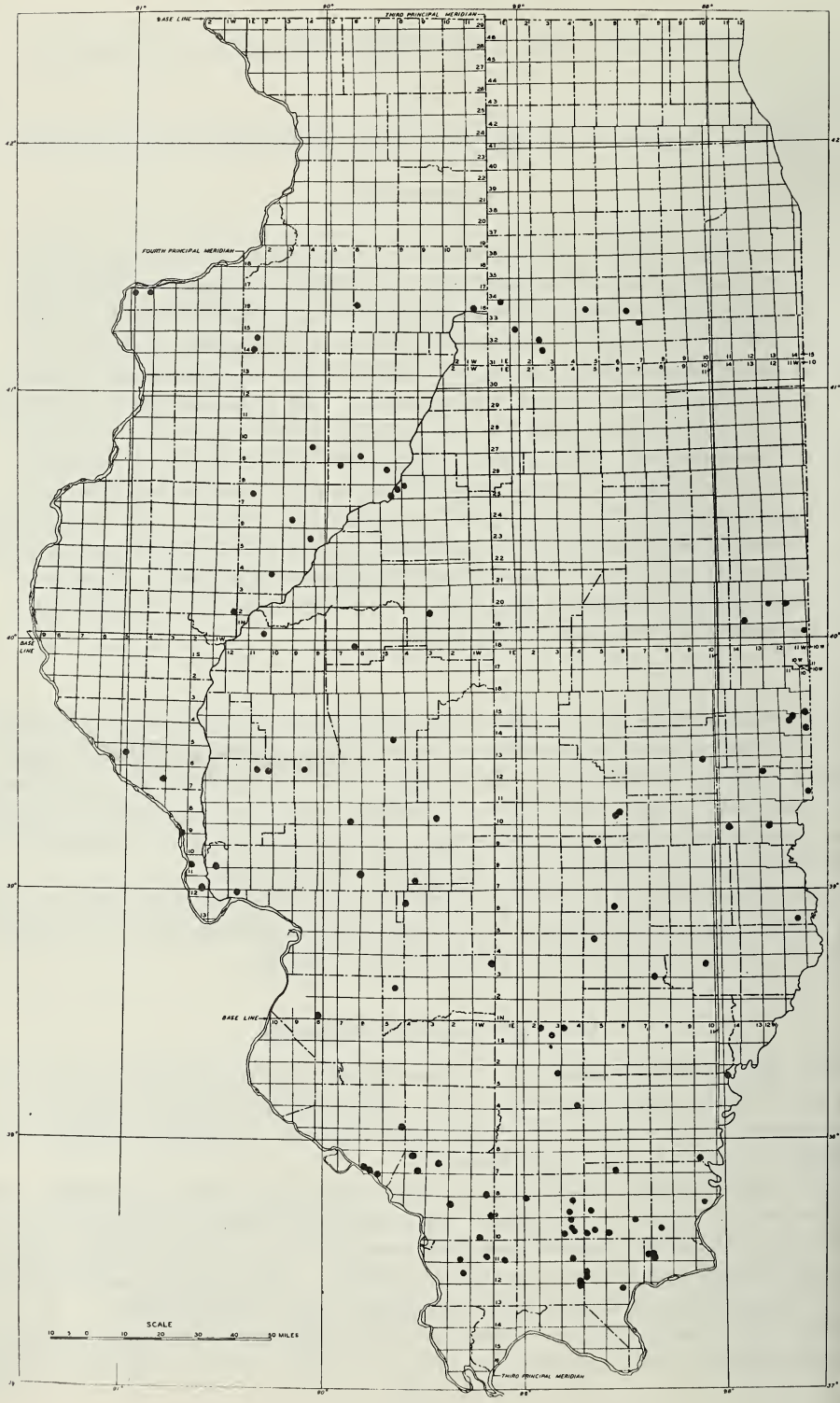

Fig. 1. - Locations of shales sampled.

to grayish black. The maximum thickness sampled from an outcrop was 25 feet. Twenty-two samples were taken.

The Hannibal and Maple Mill shales of the Kinderhook series (Lower Mississippian) crop out in Jersey, Pike, and Calhoun counties in western Illinois. Five samples were taken in Jersey County, two in Calhoun, and two in Pike. The shales are gray to dark gray.

Mississippian-Devonian black shale crops out in Hardin County, where it is known as the New Albany shale, and in Union County, where it is known as the Mountain Glen shale. It has a maximum thickness of 50 feet in Union County and possibly as much as 400 feet in Hardin County. However, in Hardin County only about 25 feet of relatively unweathered shale suitable for sampling was found. Nineteen samples of southern Illinois shale were obtained.

Another shale of Mississippian-Devonian age, the Grassy Creek shale, occurs in Pike County. It is about 50 feet thick and dark gray to black. Two five-foot samples were taken.

The Ordovician (Maquoketa) shale is ordinarily gray. Three samples were included in this study because the formation is comparatively thick and is commonly exposed in parts of Calhoun County and in northwestern Illinois.

Phosphatic Materials

Some of the Pennsylvanian black shales contain small pebble-like nodules and lenticular bands or irregular masses of brownish-gray phosphatic material, which are generally more radioactive than the shale in which they occur. Samples D6c, D9a, D9b, D77a, and D103 contain phosphatic materials.

The basal few feet of the Maquoketa shale in Jo Daviess County also includes scattered phosphatic nodules. Sample M9 contains such nodules.

Character of Black Shales

The dark gray to black color of Illinois shales is caused primarily by carbonaceous material. The shales are believed to have been deposited in seas that covered large portions of the State. Many of the black, or almost black, hard, brittle shales that break into thin layers are known popularly as "black slates," but they are not true slates.

Some black shales, especially the hard black shales above coals, contain iron sulfide in the form of the brassy yellow minerals pyrite and marcasite, which weather to yellow sulfur or to yellow, brown, or red minerals composed of iron oxides.

Sampling and Preparation for Testing

Samples were taken in strip mines, road cuts, and stream cuts where reasonably unweathered material could be obtained. Samples were collected to give a wide distribution throughout the State (fig. 1) and to represent the majority of the outcropping shale units and formations (table 1). Most samples were taken by cutting channels in the face of exposed rock. The greatest thickness of shale represented by one sample was eight feet; the sample weighed about 20 pounds. Samples were crushed to a maximum diameter of about 1/10

of an inch for radiometric and chemical analyses. A particle-size analysis of a crushed sample follows.

Mesh size	Percent
+8	1.6
-8+16	31.6
-16+35	27.2
-35+65	11.7
-65+100	13.3
-100+150	2.5
-150	12.1

Radiometric assays were made with a laboratory model Geiger counter, which was standardized against samples furnished by the Atomic Energy Commission. The assays indicate roughly the total amount of radioactive materials in a sample, including thorium and other radioactive substances as well as uranium, expressed in terms of the percentage of uranium oxide that would show an equivalent amount of radioactivity. Such a value is known as the percent equivalent uranium and is not necessarily a true measure of the uranium oxide content.

Chemical analyses for uranium oxide content were made according to procedures recommended by the Atomic Energy Commission in their booklet, "Manual of Analytical Methods for the Determination of Uranium and Thorium in Their Ores." Color measurements were made with a Beckman Model DU spectrophotometer with 10 cm. Corex cells standarized against samples supplied by the Atomic Energy Commission.

Seventeen shale samples and two samples containing phosphatic material were analyzed chemically. They were selected to represent shales of wide geographic distribution from a number of rock units and formations. Most of them had an equivalent uranium value of more than .01 percent (1/100 of one percent).

Results of Tests

Results of equivalent uranium assays on 175 samples of shale are given in table 2. Determinations of uranium oxide for 15 shales are shown in table 3. Data on five samples of phosphatic material from shales appear in table 4.

Conclusions

All the shale samples tested gave uranium oxide or equivalent uranium values below .02 percent (2/100 of one percent). The lowest grade of ore on which the Atomic Energy Commission has quoted prices contains .1 percent (1/10 of one percent) uranium oxide. Thus none of the shales tested appears to be of commercial importance at the present time.

Chemical determinations of the percentage of uranium oxide (table 3) in 15 representative shale samples showed a maximum uranium oxide content of .014 percent. The percent equivalent uranium was higher than the percent uranium oxide in nine samples. It was lower by an average of .003 percent for five samples and equal for one sample.

The ranges in percent equivalent uranium for shales of the four geologic ages represented were: Pennsylvanian, .000 to .017; Mississippian, .000 to .009; Devonian-Mississippian, .001 to .014; and Ordovician, .001 to .002. Chemical analyses of certain samples gave ranges in uranium oxide of .001 to .014 percent for the Pennsylvanian shales and .006 to .013 percent for the Mississippian-Devonian shales. Determination of uranium oxide content was not made on the Mississippian or Ordovician samples because the radiometric assays were low.

No obvious regional variations in the equivalent uranium values of the shales were noted. The highest value, .017 percent equivalent uranium, was recorded from a Gallatin County sample. The counties that yielded one or more samples having equivalent uranium values in excess of .01 percent and the higher value in each county, in order of decreasing radioactivity, were Gallatin, .017; Saline, .016; Hardin and Sangamon, .014; Union, .013; Clinton, Johnson, and Williamson, .012; and Fulton, Jefferson, Schuyler, and Vermilion, .011.

There is considerable variation in the equivalent uranium values of samples taken at different places from the same shale unit or formation. The values also vary vertically within the same formation or unit. The geologic units represented by two or more samples having the highest average equivalent uranium values were the Stonefort and Davis shales with averages of .008 percent, and the New Albany, Liverpool, Macoupin, Shoal Creek, and Cohn shales with a .007 percent average.

Variations in percent equivalent uranium within geologic systems ranged from an average of .002 for the Ordovician to .007 for the Devonian-Mississippian. The Mississippian and Pennsylvanian averaged .004 and .004+, respectively.

Black shales appear to have slightly higher equivalent uranium values than gray or dark-gray shales. The maximum equivalent uranium value for the black shales was .017 percent, for the gray and dark-gray shales, .013. The average equivalent uranium value for 92 black shale samples was .005, for 73 gray and dark-gray shales, .004 percent.

Phosphatic bands and nodules in the black shales had greater radioactivity than the associated shales. The two phosphatic samples tested chemically had uranium oxide percentages equal to, or greater than, the equivalent uranium values. Bands of phosphatic material occurring between layers of shale represented by sample D77 gave a reading of .065 percent equivalent uranium as compared with a .003 percent equivalent uranium for the shale and phosphatic material together.

Table 1. - Sequence of Shale Beds and Geologic Units Sampled

Beds sampled	Geologic unit	Sample numbers
	Pennsylvanian (Coal Measures)*	
	McLeansboro group	
Shales above Upper McLeansboro coals	Position uncertain	D15, D16, D20
Shale above Shumway coal	Shumway	D14, D96
Shale above Trowbridge coal	Shelby	D13
Shale about 10 ft. below Trowbridge coal	Shelby	D12
Shale about 25 ft. above Omega limestone	Unnamed	D97
Shale above Upper Bogota coal	Bogota	D47, D49U, D49L, D50
Shale above Cohn coal	Cohn	D9, D9a, D9b
Shale above coal that crops out near town of Divide	Unnamed	D17, D18, D19, D90, D94, D95
Shale below limestone	LaSalle and Livingston	D57, D86
Shale about 50 ft. above Shoal Creek limestone	Unnamed	D78
Shale about 30 ft. below Livingston limestone	Unnamed	D2, D87, D93
Shale below Shoal Creek limestone	Shoal Creek	D10, D11, D21, D70, D72, D92, D99
Shale above Macoupin coal	Macoupin	D44, D71, D73, D77, D77a, D88, D89, D91, D98
Shale above Brouillett coal	Brouillett	D85
Shale above Exline limestone	Gimlet	D63
Shale below Lonsdale limestone	Gimlet	D10Z
Shale above lower Scottville coal	Gimlet	D74
Shale above Cutler Rider II coal	Unnamed	D30
Shale above No. 7 coal	Sparland	D5, D5a, D5b, D59, D60, D65, D69, D100
	Carbondale group	
Shale above Jamestown limestone	Jamestown	D81
Shale above Herrin limestone	Brereton	D80U, D80L
Shale above No. 6 coal	Brereton	D4, D6a, D6b, D6c, D31, D46, D51, D79, D82

*Most of the units in the Pennsylvanian system are called cyclothems.

Table 1. (continued)

Beds sampled	Geologic unit	Sample numbers
Shale above No. 5 coal	St. David	D1, D37U, D37L, D53, D54, D55, D64, D66, D67, D103
Shale above No. 4 coal	Summum	D3, D3a, D3b, D33, D38, D52, D76
Shale above No. 2 coal	Liverpool	D22U, D22L, D42, D56, D58, D68, D75, D101
	Tradewater group	
Shale above Dekoven coal	Dekoven	D26, D34
Shale above Davis coal	Davis	D24, D25, D32
Shale above Campbell Hill coal	Unnamed	D83
Shale below Seahorne limestone	Seahorne	D43
Shale above Stonefort limestone	Stonefort	D23, D27, D35
Shale below Stonefort limestone	Stonefort	D28
Shale above limestone (D61a and D62a at base of exposures)	Seville	D61a-f, D62a-d
Shale below limestone	Seville and Curlew	D29, D45, D48
Shale above Murphysboro coal	Unnamed	D7, D39U, D39L
"Ava" shale	"Ava"	D8
Shale above Willis coal	Grindstaff	D84
	Caseyville group	
Shale at position of Reynoldsburg coal	Pounds	D36
Shale at position of Battery Rock coal	Battery Rock	D40
Shale below Battery Rock coal	Battery Rock	D41
	Mississippian Chester series	
Shale	Formation uncertain	A20
Shale	Clore formation	A21-A24, A27, A32
Shale about 25 ft. above base of formation	Clore formation	A5
Shale at base of formation	Clore formation	A6
Shale 25 ft. below top of formation	Clore formation	A7
Shale 27 1/2 ft. below top of formation	Clore formation	A8
Shale from top of formation	Clore formation	A25
Shale from base of formation	Clore formation	A26
Shale at contact of formations	Clore and Palestine formations	A30

Table 1. (continued)

Beds sampled	Geologic unit	Sample numbers
Shale below A30	Palestine formation	A31
Shale	Menard formation	A28
Shale below A28	Menard formation	A29
Shale at contact of formations	Menard-Waltersburg formations	A1
Shale; samples in ascending order A2, A3, and A4	Waltersburg formation	A2-A4
Shale	Tar Springs	A33
	Kinderhook series	
Shale near top of formation	Hannibal formation	A34
Shale at base of outcrop	Hannibal formation	A42
Shale, 0-3 and 5-7 ft. above A42	Hannibal formation	A43
Shale at top of formation	Hannibal formation	A46
Shale	Maple Mill member (black-shale facies)	A37
Shale, above A37	Maple Mill member (black-shale facies)	A38
Shale from base of formation; in ascending order A39, A40, A41	Maple Mill member (black-shale facies)	A39-A41
	Devonian-Mississippian	
Shale, A45 above A44	Grassy Creek formation†	A44, A45
Shale, 35 ft. above creek	Mountain Glen formation†	A9
Shale, at base of formation	Mountain Glen formation†	A10
Shale 10 to 30 ft. above base of formation; samples in ascending order	Mountain Glen formation†	A11-A14
Upper 25 ft. of formation; samples in descending order	Mountain Glen formation†	A15-A19
Shale, position in formation not known; samples in descending order	New Albany formation†	M1-M5
Shale, position in formation not known; M6 above M7	New Albany formation†	M6, M7
Shale, position in formation not known	New Albany formation†	M8
	Ordovician	
Shale below 6 in. red zone in basal part of formation	Maquoketa formation	A35

Table 1. (continued)

Beds sampled	Geologic unit	Sample numbers
Shale above 6 in. red zone in basal part of formation	Maquoketa formation	A36
Shale from "Depauperate zone" near base of formation	Maquoketa formation	M9

†These formations are roughly the same geologic age.

Table 2. - Location and Percent Equivalent Uranium of Shale Samples

County	Sample	Location 1/4	1/4	1/4	sec.	T.	R.	Thickness inches	% eU*	Sample source†
Bond	D78	SW	NE	SE	19	6N	4W	10	.000	Stream cut
Bureau	D46	SW	NE	NE	29	16N	6E		.006	Strip-mine dump
"	D57	NE	SW	NW	33	16N	11E	7	.000	Stream cut
Calhoun	A34		NW	NE	35	9S	3W	60	.007	Weathered bluff**
"	A36	SE	NE	SW	17	11S	2W	60	.001	Valley wall**
"	A35	SE	NE	SW	17	11S	2W	60	.002	Valley wall**
"	A46	C	SW	NE	23	12S	2W	72	.005	Quarry**
Cass	D101	SW	SW	NE	11	18N	11W	26	.001	Bluff
Clark	D90	SE	SW	NW	4	9N	12W	22	.004	Stream cut
"	D91	SE	NE	SE	3	9N	12W	31	.004	Stream cut
"	D92	SE	NW	SE	3	9N	12W	10	.004	Stream cut
"	D93	SW	NW	SE	3	9N	12W	32	.001	Stream cut**
"	D89	NE	NW	NW	20	11N	10W	33	.009	Road cut
"	D94	SE	NE	SE	30	12N	12W	12	.004	Road cut
Clay	D50	SW	SE	SW	32	3N	8E		.004	Stream cut
"	D97	SW	SW	SW	10	4N	5E	72	.006	Valley wall
Clinton	D99	SW	SE	SE	22	2N	5W	26	.012	Stream cut
"	D98	NE	SW	NE	13	3N	1W	12	.000	Stream cut
Coles	D95	SW	SW	SE	3	12N	10E	10	.002	Stream cut
Crawford	D47	SE	SW	NW	14	5N	11W	32	.002	Stream cut
Edgar	D88	SW	NE	SW	29	14N	10W	16	.009	Stream cut
"	D87		C	SW	2	14N	11W	15	.000	Stream cut**
"	D86	SE	SE	SE	10	14N	11W	24	.006	Stream cut
"	D85	NW	SE	NW	32	15N	10W	14	.002	Road cut
Effingham	D96	SE	NE	NW	28	6N	6E	31	.003	Stream cut
"	D14	SE	SE	SW	26	9N	5E	34	.001	Stream cut
Fulton	D67		N	NE	3	3N	2E	15	.007	Strip mine
"	D42	NE	NW	NW	17	5N	4E	24	.006	Stream cut
"	D66	NW	SW	SW	28	6N	3E	20	.002	Strip mine
"	D43	SW	SE	NW	14	7N	1E	15	.002	Stream cut
Gallatin	D44	SE	NE	NW	16	9S	10E	30	.017	Stream cut
"	D1		C	NW	16	10S	8E	36	.004	Strip mine
Greene	D76	NW	SE	NW	21	12N	11W	30	.003	Strip mine**
"	D75	SW	SW	SW	24	12N	11W	30	.009	Strip mine
Grundy	D54	NW	SE	NE	1	32N	7E	18	.002	Stream cut
"	D53	SE	NW	NW	20	33N	7E	22	.004	Stream cut

*eU = equivalent uranium.
**Gray, dark gray, or grayish black.
†All samples are black except those double-starred.

Table 2. (continued)

County	Sample	Location 1/4	1/4	1/4	sec.	T.	R.	Thickness inches	% eU*	Sample source†
Hardin	M1	SW	NW	SE	25	11S	7E	36	.003	Stream cut**
"	M2	SW	NW	SE	25	11S	7E	60	.003	Stream cut
"	M3	SW	NW	SE	25	11S	7E	60	.003	Stream cut
"	M4	SW	NW	SE	25	11S	7E	60	.014	Stream cut
"	M5	SW	NW	SE	25	11S	7E	60	.009	Stream cut
"	M8	SW	SE	SE	30	11S	8E	48	.003	Road cut
"	M6	SE	NE	NE	31	11S	8E	60	.001	Road cut
"	M7	SE	NE	NE	31	11S	8E	60	.006	Road cut
Henry	D48	SE	NW	SE	11	14N	1E		.006	Mine dump
"	D45	NE	NE	NE	33	14N	1E		.004	Mine dump
Jackson	D7	NW	NE	SW	22	7S	3W	30	.000	Strip mine
"	D83	NW	SE	NE	4	7S	4W	30	.003	Stream cut
"	D8	SE	SE	NE	35	7S	4W	48	.003	Stream cut**
"	D38	SE	NW	NW	35	8S	1W	36	.008	Mine entry
"	D39U	NE	SW	NE	36	9S	1W	30	.001	Strip mine
"	D39L	NE	SW	NE	36	9S	1W	60	.003	Strip mine**
"	D84	SW	SE	NE	19	9S	2W	24	.003	Stream cut**
"	D40	SW	NW	NW	33	10S	1W	22	.000	Stream cut
"	D41	SW	NW	NW	33	10S	1W	18	.001	Stream cut**
Jefferson	D15	SE	SW	SE	7	1S	3E	18	.005	Stream cut
"	D16	NW	SW	SW	22	1S	3E	15	.011	Road cut
"	D17	NW	SW	SW	7	1S	4E	15	.003	Road cut
"	D18	SE	SE	SE	13	3S	3E	38	.003	Stream cut**
"	D19	SE	SE	SE	13	3S	3E	12	.000	Stream cut
"	D20	NE	NE	SE	35	4S	4E	40	.001	Stream cut
Jersey	A38		NE	SE	4	6N	12W	60	.007	Stream cut**
"	A37		NE	SE	4	6N	12W	60	.008	Stream cut**
"	A41	SW	SE	NW	34	8N	13W	60	.000	Valley wall**
"	A40	SW	SE	NW	34	8N	13W	60	.004	Valley wall**
"	A39	SW	SE	NW	34	8N	13W	60	.004	Valley wall**
Jo Daviess	M9	NE	SE	SW	26	29N	2E	12	.002	Railroad cut**
Johnson	D36	SE	NE	SE	33	11S	4E	27	.012	Stream cut
"	A28	NE	SW	NE	36	12S	4E	72	.003	Railroad cut**
"	A29	SE	SE	NW	1	13S	4E	48	.001	Railroad cut**
Knox	D64			S	8	9N	4E	22	.008	Strip mine
LaSalle	D51	SE	SE	SE	9	31N	3E	24	.000	Road cut
"	D56		SE	SW	8	32N	2E	22	.008	Stream cut
"	D52		SW	SE	32	32N	3E	29	.007	Stream cut
"	D58	NE	NE	NE	3	33N	1E	14	.002	Stream cut
"	D55	SW	SE	NE	21	33N	5E	14	.004	Stream cut
Logan	D102	SW	NE	NE	7	19N	3W		.000	Blocks from quarry floor**

Table 2. (continued)

County	Sample	Location 1/4	1/4	1/4	sec.	T.	R.	Thickness inches	% eU*	Sample source†
Macoupin	D77	SW	NE	NE	12	7N	7W	24	.003	Stream cut
"	D73	SE	SE	SW	35	10N	7W	24	.006	Stream cut
"	D72	SW	SW	SE	35	10N	7W	36	.004	Stream cut
"	D74	NW	SW	NW	16	12N	9W	18	.006	Stream cut
Menard	D100	C	NW	NW	36	18N	7W	12	.005	Stream cut
Montgomery	D11	SW	SW	SE	21	7N	4W	18	.009	Stream cut
"	D71	NE	SE	NW	28	10N	3W	26	.004	Stream cut
Peoria	D59		C	SE	23	7N	7E	7	.002	Road cut
"	D63		C	NE	3	8N	5E	4	.003	Stream cut
"	D69	NE	NE	SW	11	8N	7E	14	.006	Road cut
"	D65		NE	SW	28	9N	6E	10	.002	Road cut
Pike	A45		NE	SW	17	6S	5W	60	.008	Stream cut**
"	A44		NE	SW	17	6S	5W	60	.003	Stream cut**
"	A43	C	NW	NE	24	7S	4W	60	.003	Road cut**
"	A42	C	NW	NE	24	7S	4W	60	.003	Road cut**
Pope	A25	SW	NW	SE	19	12S	5E	48	.002	Railroad cut
"	A21	SE	SE	SW	19	12S	5E	36	.006	Railroad cut
"	A22	SE	SE	SW	19	12S	5E	48	.000	Railroad cut**
"	A23	SE	SE	SW	19	12S	5E	24	.000	Railroad cut
"	A24	NW	SW	SE	19	12S	5E	42	.000	Railroad cut
"	A27	SW	NW	SE	19	12S	5E	72	.002	Railroad cut
"	A26	SW	NW	SE	19	12S	5E	48	.003	Railroad cut
"	A30	NW	SW	SW	30	12S	5E	60	.008	Railroad cut
"	A31	NW	SW	SW	30	12S	5E	60	.006	Railroad cut
"	A33	SE	SE	SE	11	13S	6E	90	.001	Road cut
Randolph	D81	NE	SW	NE	36	5S	5W	33	.001	Strip mine
"	D80U	NE	SW	NE	36	5S	5W	60	.000	Strip mine
"	D80L	NE	SW	NE	36	5S	5W	60	.000	Strip mine
"	D82	NW	SW	NE	36	5S	5W	34	.002	Strip mine
"	A1	NW	NW	NE	32	7S	6W	60	.006	Stream cut
"	A2	NW	NW	NE	32	7S	6W	60	.007	Stream cut
"	A3	NW	NW	NE	32	7S	6W	60	.005	Stream cut
"	A4	NW	NW	NE	32	7S	6W	36	.001	Stream cut
"	A5	SW	NE	SE	33	7S	6W	30	.004	Stream cut
"	A6	SW	NE	SE	33	7S	6W	48	.003	Stream cut
"	A7	SW	SE	SE	2	8S	6W	24	.002	Quarry
"	A8	SW	SE	SE	2	8S	6W	30	.009	Quarry
Richland	D49U	SW	SW	SE	15	3N	10E	36	.006	Stream cut
"	D49L	SW	SW	SE	15	3N	10E	36	.000	Stream cut
Rock Island	D61a	NE	NE	SW	1	16N	5W	60	.007	Stream cut
"	D61b	NE	NE	SW	1	16N	5W	60	.004	Stream cut
"	D61c	NE	NE	SW	1	16N	5W	60	.002	Stream cut

Table 2. (continued)

County	Sample	Location 1/4	1/4	1/4	sec.	T.	R.	Thickness inches	% eU*	Sample source†
Rock Island	D61d	NE	NE	SW	1	16N	5W	60	.004	Stream cut
"	D61e	NE	NE	SW	1	16N	5W	60	.006	Stream cut
"	D61f	NE	NE	SW	1	16N	5W	60	.001	Stream cut
"	D62a	SE	SE	SW	6	16N	5W	60	.000	Road cut
"	D62b	SE	SE	SW	6	16N	5W	60	.004	Road cut
"	D62c	SE	SE	SW	6	16N	5W	60	.000	Road cut
"	D62d	SE	SE	SW	6	16N	5W	60	.002	Road cut
St. Clair	D79	SE	SE	NW	31	1N	8W	31	.003	Strip mine
Saline	D21	NE	NE	SW	33	7S	6E	10	.007	Stream cut
"	D31	SW	NE	SW	29	9S	5E	23	.008	Strip mine
"	D26		NE	NW	21	10S	5E	30	.002	Strip mine
"	D25		NE	NW	21	10S	5E	22	.007	Strip mine
"	D27	NW	NE	NE	30	10S	5E	35	.013	Railroad cut
"	D28	NW	NE	NE	30	10S	5E	20	.001	Railroad cut
"	D24	NE	SE	NE	30	10S	6E	10	.016	Stream cut
"	D23	NE	SE	NE	30	10S	6E	17	.004	Stream cut
"	D22U	C	SW	NW	5	10S	7E	15	.007	Stream cut
"	D22L	C	SW	NW	5	10S	7E	18	.008	Stream cut
Sangamon	D70	NW	NE	SW	3	13N	5W	17	.014	Stream cut
Schuyler	D68	cen. sec.			36	2N	1W	38	.011	Stream cut
Shelby	D13	NW	NW	NE	14	10N	6E		.002	Mine dump
"	D12	NW	NE	SW	22	10N	6E	30	.003	Road ditch
Tazewell	D60	NE	NE	NW	18	25N	4W	5	.004	Stream cut
Union	A32	SE	SW	SE	33	11S	1E	72	.000	Stream cut**
"	A20	NW	SE	SW	26	11S	1W	36	.006	Road cut
"	A14		C	NE	34	11S	2W	60	.008	Stream cut**
"	A13		C	NE	34	11S	2W	60	.007	Stream cut**
"	A12		C	NE	34	11S	2W	60	.011	Stream cut**
"	A11		C	NE	34	11S	2W	60	.013	Stream cut**
"	A9	SE	NE	NE	34	11S	2W	60	.007	Stream cut**
"	A10	SE	NE	NE	34	11S	2W	24	.008	Cut bank**
"	A15	SW	NW	SE	14	12S	2W	60	.005	Valley wall**
"	A16	SW	NW	SE	14	12S	2W	60	.008	Valley wall**
"	A17	SW	NW	SE	14	12S	2W	60	.008	Valley wall**
"	A18	SW	NW	SE	14	12S	2W	60	.008	Valley wall**
"	A19	SW	NW	SE	14	12S	2W	60	.004	Valley wall**
Vermilion	D3	SW	NW	NW	13	18N	11W	14	.011	Stream cut
"	D3a	SW	NW	NW	13	18N	11W	5	.002	Stream cut**
"	D3b	SW	NW	NW	13	18N	11W	4	.003	Stream cut**
"	D4	SE	SE	SE	6	19N	11W	23	.007	Stream cut
"	D5			SE	4	19N	12W	17	.002	Strip mine**
"	D5a			SE	4	19N	12W	3	.004	Strip mine, top 3 in. of A5**

Table 2. (continued)

County	Sample	Location 1/4	1/4	1/4	sec.	T.	R.	Thickness inches	% eU*	Sample source†
Vermilion	D5b			SE	4	19N	12W	1	.002	Strip mine, bottom 1 in. of A5**
"	D2	NW	NW	SW	31	19N	13W		.004	Stream cut
White	D9		SW	SW	21	3S	14W	12	.007	Stream cut
"	D10	SE	SW	SE	17	7S	10E	12	.005	Stream cut
Williamson	D37U		NE	SW	4	9S	2E	36	.001	Strip mine
"	D37L		NE	SW	4	9S	2E	36	.006	Strip mine
"	D30	SE	SW	NW	10	9S	4E	41	.001	Stream cut
"	D6a		NE	NE	28	9S	4E	9	.011	Strip mine, bottom 9 in.
"	D6b		NE	NE	28	9S	4E	21	.006	Strip mine, upper 21 in.
"	D33	NW	SE	NW	4	10S	4E	36	.001	Stream cut
"	D34	NW	SW	NW	16	10S	4E	24	.006	Valley wall
"	D32	NE	SE	NE	16	10S	4E	33	.001	Stream cut
"	D35	SW	SW	NW	22	10S	4E		.012	Road cut
"	D29	NW	NE	SW	30	10S	4E	18	.002	Road cut

Table 3. - Percent Uranium Oxide (U_3O_8) of Shale Samples

Sample	% U_3O_8	Sample	% U_3O_8	Sample	% U_3O_8
D3	.014	D35	.013	D70	.010
D6A	.006	D36	.001	D89	.014
D16	.012	D44	.014	D99	.013
D27	.008	D56	.003	A11	.013
D24	.009	D68	.008	M+	.006

Table 4. - Analyses of Phosphatic Materials

		Location								
County	Sample	1/4	1/4	1/4	sec.	T.	R.	% eU	% U_3O_8	Remarks
Macoupin	D77a	SW	NE	NE	12	7N	7W	.065	.075	Phosphatic bands from sample D77
Tazewell	D103	NW	NE	SE	24	25N	5W	.013		Mine dump; phosphatic bands and nodules
White	D9a		SW	SW	21	3S	14W	.019		Phosphatic siltstone above Cohn coal
White	D9b		SW	SW	21	3S	14W	.019	.019	Phosphatic nodules from sample D9
Williamson	D6c		NE	NE	28	9S	4E	.011		Strip mine; random blocks of black shale containing phosphatic nodules and bands

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